

ABSTRACT

There are many important factors to consider when planning work and estimating the costs for stream habitat restoration projects. These factors range from the people and organizations involved in planning, coordinating and carrying out the project to the specific physical characteristics of the watershed in which the work is done. This paper addresses the difficulties involved in developing restoration projects, especially in estimating project costs. It also discusses the issues that must be raised whenever restoration projects are aggregated for planning on a larger scale (counties or regions).

INTRODUCTION

In order to design, plan and execute stream habitat restoration projects, care must be taken to understand the watershed in detail. If project planners do not have in-depth knowledge of the entire watershed, it is possible that restoration projects will fail due to a design that addresses a local problem on a stream without treating any of the root causes of stream degradation throughout the system. On a larger scale, it is important to understand that conditions vary between watersheds. This variability can arise from a variety of sources, including both human and natural conditions.

People, Agencies and Communication

Project costs vary considerably depending on who is doing the work. The variation is based primarily on the fact that contractors and staff from different agencies and companies bill different rates for their work. Using contractors for restoration work can be very expensive. The Natural Resources Conservation Service (NRCS) contracts out the work undertaken to ensure that our restoration projects comply with National Environmental Policy Act (NEPA) regulations. Contractors must charge between two and three times what the normal Federal salary is to break even. For example, if a private contractor has a salary of \$30 to \$40 an hour, he or she will charge at least \$120 an hour in order to have the same level of insurance,

retirement and vacation as a federal employee. Consulting companies have overhead too, which adds to the cost.

When a project involves contract construction and equipment operation, it is necessary for the coordinating agency to invest time in developing a very detailed work plan so that the contractor will complete the work in an appropriate and satisfactory manner. In addition, our inspector must be on site to be sure that the project plan is being followed. If we do the work ourselves, in-house, it is not as important to spell everything out in the plan, because our engineers and fish biologists will be directing the workers and will know what needs to be done in any given situation to make the project successful. However, there can be benefits to contracting work out. The contractor absorbs the risks and the downtime involved in the project, which means that he or she needs to incorporate the uncertainty of working in a natural system into all bid estimates.

The work market and location also have an impact on the final project cost. A loader operator who is an owner/operator in a depressed timber area will charge much less when a potential job comes along. At the same time, an operator in Southern California who is working steadily and making a lot of money is going to be reluctant to come to Northern California without the promise of considerable money. Differences between rates charged by contractors can be as much as a half million dollars per mile.

Another important consideration when dealing with people in relation to a restoration project is the possibility of disputes with other landowners in the area. It is important to spend time negotiating with local stakeholders so that the project is not stopped later when considerable time and money have already been invested. It is much easier to work with landowners who are our friends

than landowners who are really angry. An angry landowner can get his or her friends just as angry, creating public resistance. Ensuring that we are able to do important restoration work in an area sometimes means making compromises.

One of the most important steps toward developing a successful restoration project is acquiring a comprehensive understanding of what all of the problems are in the stream system under consideration. Knowing what is wrong at just one spot may not be very helpful, and can mean that treatments devised without having a larger perspective are unsuccessful. Without having a good understanding of the system, it is also more difficult to obtain the permits necessary to do the job. As a result, we have discovered the extreme importance of good communication with all of the people who have knowledge of the area. An important component of what we do is to talk to geologists, engineers, fish biologists, vegetation specialists, soil specialists and hydrologists, in order to build a larger picture of the landscape. It is also crucial for us to be able to explain to other people the work that we are doing. Good communication can make many aspects of the project planning and implementation processes run more smoothly.

Physical Characteristics of the Landscape

Understanding the history and current state of the stream system is crucial. Knowledge of the floodplain has proven to be a serious issue. Without understanding the history of California's redwood country, it is difficult to make sense of the current landscape. When this area in California was logged, the standard process was to put up a 25 to 30 foot wooden dam, fill the dam with logs, and wait. When winter came and the dam was filled with the river running over the top, the loggers would blast the dam and the stream would run straight down its

gradient to places like Point Arena and Gualala and other small coastal communities. The flow would literally move every bit of wood and sediment in the system down the gradient. The result is that bedrock and very poor habitat now dominate these streams. Without knowing this history, we might not understand how this system with lots of large wood has streams that only contain bedrock.

In California much effort in the last 80 years has been spent fighting fires, in particular in some of the Sierra systems where there are truly beautiful meadows. Looking at the soil layers under the meadow, most of the layers are of organic soil and white granitic sand. Once you reach the layers deposited in the last 80 years, though, all of a sudden there is a solid 15 to 18 inches of organic material and no gravel or sand. Fighting fires has eliminated a source of sediment for the streams. Now people are finally starting to realize that fires provide some of the materials necessary for the creation and maintenance of good habitat.

Terraces on the upper elevations of the watershed are consistent features of the landscape that we work in. Terraces are abandoned floodplains; as the stream cuts deeper into its substrate, new floodplains are developed at the lower elevation, leaving terraces above. Lack of riparian vegetation on floodplains and terraces is a big problem, and leaves the streambank unprotected during flood events. It is very difficult to revegetate many of the areas in which we work because much of the land ownership is private and grazing is very prevalent. In areas where cattle are not grazed, deer and other wildlife prevent the establishment of new plants.

Spanish Creek, one of the streams in our area, is an example of a fairly healthy system because the stream has relatively good contact with the flood plain and has sufficient vegetation. Because the stream has an appropriate amount of meander and interacts well with the flood plain, it will be possible for us to induce reasonably rapid recovery.

Our region is probably the most active part of the world with respect to landslides. There are a number of features of the landscape that contribute to this activity. The streambeds are composed largely of bedrock. There is a lot of large woody debris on the hillsides, which are very steep. A landslide is composed of fine-grain sediment and a large number of rocks and trees. Once a landslide has begun, it crashes against the other side of the valley wall and stops, creating a cascade with large wood holding it together. Then, after a large event such as this, the slide incrementally meters out bedload into the stream system. If the area is logged, with all of the large wood removed, there is nothing left to hold all of the material together, and another landslide is inevitable.

Logging has eliminated in 10 to 15 years all the root systems that were holding the mountains together. Instead of a big landslide every 120 years, we now see 40 landslides every 10 years or so. As a result, fine-grain sediment is entering the coastal range systems that are starved for large wood. There is less coarse-grain sediment because the deep-seated landslides are no longer the dominate landslide mechanism in these systems.

Due to differences in location, local conditions and land management, stream systems vary widely, which makes extrapolation to a general level difficult. Some of the available tools for characterizing streams are the various classification theories, including those of Rosgen, Horton, Chum, Montgomery, and Buffeton. When Rosgen's idea was first proposed, it was fairly simple, designed to group streams into a small set of possible categories. Many of the classification systems were simple at the beginning. Horton classified streams using a combination of eight

parameters, which allows for 164,000 different combinations. Classification is important because it enables everyone to communicate with each other about streams, but it is important to remember that each stream system is different and should also be considered individually.

Here is another way of looking at stream systems: across landscapes. Depending on location, there will be high mountains, bedrock, glacial material, transport material, and depositional areas. A valley in the depositional phase is depositing and storing sediment. Once logging and other changes to the upper elevation landscape start to occur, the streams in that valley may start transferring the sediment. In the Pacific Northwest, in coastal California, in the Sacramento flood plains, when we transform a depositional reach into a transport reach, it is very bad for the health of the watersheds, leading to massive sediment build-up and the loss of complex stream habitats.

STREAM HABITAT TREATMENTS

Channel Evolution: Space vs. Time

Stream channels evolve over time. The channel evolution model consists of four steps. First, there is the pre-incision stage, where the channel has not started to cut into the substrate. Next is incision, which begins at a primary nick point. The channel then widens, allowing the accumulation of deposits on the channel floor. Finally, the stream reaches a state of dynamic stability. The changes that channels undergo over time can be dramatic. We have talked to an owner who said that as a kid, he could swing a rope across his creek. Standing on the edge of a 25-foot wide channel, we imagine that he must have been one brave kid! In reality, when he was young, the channel was not very deep and was only about six feet across; in 70 years the channel has changed considerably.

Restoration projects should always be considered in the context of time. This is not always easy; in many cases, no one is around who knows what the landscape used to be like. In other cases, the land use has changed so much or is now changing so quickly that it is difficult to determine the channel's current stage of evolution. This makes it more difficult to correctly define the problem to address with restoration work. For example, the NRCS attempted to treat an eroding meander reach that was immediately downstream of a small highway bridge on Salmon Creek near Vancouver. We upgraded the bridge, which concentrated stream flow so that increased velocity through the bridge eroded the bank. To counteract the erosion, we put in willow and toe rock for stabilization. One reason for the bridge improvement was to accommodate subdivisions going in nearby. We learned there was a head cut about a half mile downstream of the bridge. It became clear that we could put all the good bank material we wanted on the stream and we could clear any log jams, but if we did not define the problem correctly and fix it, all money spent on peripheral problems would be wasted.

Over time, we have improved our ability to define the problem on the stream reach we are working on. We can put Band-Aids – and in a lot of cases stream bank protection measures are just that – on many of our systems and never really accomplish anything because we have not taken the time to define the problem. This is why watershed-wide analysis is important, because all of the problems within a given watershed must be addressed if the health of the stream is to improve. We may not be able to understand the entire system immediately, and sometimes we do have to make rapid decisions to treat urgent problems. We do, however, owe the people we are doing the work for at least an attempt at understanding the whole problem. We work primarily on

private lands, and clients call because, for example, their bank is eroding, their bridge is blowing out, or their vineyard is in danger. Unless we know why the system is behaving that way, we cannot select a restoration technique that will be sustainable.

Adaptive Management

Adaptive management is the basis of our planning process. All of our plans are developed with the understanding that modifications will be made over time as we become more familiar with the system and with the consequences that our treatments will have on the landscape. It can be difficult for management, lawmakers and fiscal staff to acknowledge that we may come back and ask for more money or make mistakes and have to learn from them. As long as we are working in natural systems, however, we need to constantly reexamine our plans with reference to the conditions in the real world. As discussed above, natural systems are always evolving. Changes in natural systems are the result of a myriad of causes, including human, ecological, geological and meteorological events. Whatever the cause of the change, though, it is crucial that restoration planning take this evolution into account.

COST ESTIMATION AND PROJECT PLANNING

Developing a cost estimate is probably the most difficult and time-consuming part of developing a watershed assessment. It is important to understand how restoration costs are distributed across ESA, region-wide or area-wide planning units. The biggest risk of watershed analysis is assuming one stream system is like another and basing cost analysis on that assumption. If the assumption is incorrect, a region-wide or watershed-wide analysis will break down. When crossing watershed divides and trying to make region-wide assessments, we must be able to group problem areas in similar

reaches, so that we are sure that the costs are comparable.

Landscape variables are the single biggest factor affecting project costs. Other issues can also impact costs, though. One important cost consideration is the skill level of the operators working on a project. There are operator schools where a lot of time is spent teaching the participants how to operate and maintain their machines. Individual operators can also learn as they work on a project and, based on experience, can become highly skilled. We have had operators who could take a bucket as big as a table and control it within about half an inch, depending on the weight of the load.

Materials are another important cost factor. Fencing can be a very cheap installation. In order to estimate the cost of a fencing project, we can go to Costco and price the fence and then price a labor source. On the other hand, when we looked at root wads or bioengineering as a stabilization solution for Indian Creek in Quincy, we realized we would have to go for a major timber sale, because it was all private land. In the private sector, trees are not free. We would have had to move more logs to treat the 7 miles of stream than had been harvested in the last five years. The supply of trees in that area had been exhausted. Unfortunately, big trees are needed for bioengineering treatments, and taking the last old-growth Sugar Pine and Ponderosa Pine in an area to fix a stream is probably not the best idea. Obtaining woody materials can be a very expensive aspect of the project.

There are a number of different cost guidelines that we use when we develop project cost estimates. The Dodge Manual provides private sector costs for heavy equipment operation. In more remote areas, where all the loggers have moved out and the heavy equipment is gone, we have to contract out our heavy equipment work. This is expensive and both the cost and the quality of the work

can be extremely variable. In areas with a good construction industry infrastructure, heavy equipment prices can be on the order of \$100-\$125 an hour. Big cranes can cost as much as \$1,000 an hour, but we do not use those as often.

The planning process itself involves a considerable amount of expense. Obtaining permits for the project can be a major hurdle. In some cases, more money may be spent on permitting that on the actual project. An Environmental Impact Statement (EIS) is time consuming and expensive, but that expense can be lessened somewhat by obtaining an EIS for the entire program, rather than on a project-byproject basis. However, even if we do a programmatic EIS, 10 years later the odds are very high that we will have to revisit the statement and, in some cases, redo the entire NEPA and California Environmental Quality Act (CEQA) process. Even though we have a record of decision because we did an original EIS, there will be new California Department of Fish and Game people, new regulatory people, new landowners, and new concerned individuals who did not agree to the original EIS. The test of a good CEQA or Federal document is that we do not get sued.

We hope to get people to see that that the most important aspect of restoration work is time. Our efforts are laying the groundwork for severely degraded systems to re-grow the vegetation that will aid in their repair. Planting trees stabilizes stream banks and upland areas, but it also provides future material in the form of large woody debris. This material will be of use in naturally maintaining future bank stability as well as providing better in-stream habitat for the fisheries. For large meadow systems that have been degraded down to a cobble surface, we recommend planting upland trees and nursing them through the deer-predation period. This treatment is fairly inexpensive,

about \$5,000 an acre. Then we wait for the next fire in the fire and flood sequence to supply the stream with the sediment it needs, particularly fine-grain sediment.

Calculating time into the restoration plan can be particularly effective in areas where our budget is limited. When we do not have the option to spend a million dollars a mile on the stream treatment, we use time as part of the equation. We set the stage for recovery by spending \$5,000 to \$10,000 per stream mile on various planting and stabilization treatments, but the system does not completely recover until a triggering mechanism, whether fire or some other kind of catastrophe, supplies the stream with the materials it needs.

Maintaining cost effectiveness must always be taken into consideration when planning projects. An economics group in California is looking at the economic values of floodplains and wetlands on a \$300,000 Environmental Protection Agency grant. They have produced a study of a restoration project that indicates that taking out levies and restoring the wetlands has more positive economic benefits than failing to restore the wetlands and leaving the levy system to degrade. There are benefits to water clarity in the lake and streams, to recreation, and to the county because they will no longer need to maintain the levies. We need more cost effectiveness studies like this, because they provide a concrete measure of the need for restoration work.

It is impossible to overestimate the value of learning from past mistakes. One very important area in which this idea needs to be applied is in development planning. For example, the best kind of flood protection is preventive, which means that we should not build in floodplains. There is an Executive Order (EO11338) that states that the Federal government will not subsidize construction in floodplains and will not provide subsidized flood insurance for houses built in documented floodplains. This sounds great, except the fact that most floodplains have not yet been mapped. So a contractor or developer can walk the Wind River Watershed and find a piece of private ground that has not been mapped because no one is living there, and then put in a subdivision. We should have learned by now that building in floodplains does not make sense, ecologically or economically.

There are excellent economic justifications to be made for not making mistakes in the first place. However, when mistakes are made, we need to have a good understanding of the system that we are working in before we start looking for solutions. A lot of the

systems that we are asked to work in have changed considerably in a fairly short amount of time since degradation of the system began. We need to discover what is going on before we start talking about the solutions we are going to implement. It is entirely possible to aggregate watersheds into larger regions in order to assign costs on a regional basis. However, this does require that we examine each watershed and group them based on the specific details that we have learned about each one. This will lead to an error between 25 and 50% in the estimate. If we work from the top down without knowing each watershed individually, the error is likely to be as much as 200 to 500%.

